



CHALLENGER 350

BD-100-1A10

ENVIRONMENTAL

STUDY GUIDE · CARD SYSTEM

A flashcard-style reference for the CL350 environmental control system (ATA 21). Covers bleed air distribution, leak detection, PACK operation, trim air, ram air, avionics cooling, and EICAS messages — all grounded in the REVISED source.

ATA 21 · AIR CONDITIONING

Section ENV · Revision: Original

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01

FIVE THINGS YOU MUST KNOW

The five highest-value facts for the oral. Memorize numbers cold.

2 IASCs	Integrated Air System Controllers — manage entire ECS
50 ± 3 psi	IPV limit — intermediate engine bleed pressure
8 zones	Bleed leak detection system EICAS zones
$15\text{ }^{\circ}\text{C} - 35\text{ }^{\circ}\text{C}$	Normal temperature control range (cabin / cockpit)
10,000 ft	Max altitude for RAM AIR valve use

TIP Five baseline numbers for the air-conditioning and bleed system: 2 IASCs, 8 leak zones, 50 psi IPV limit, 15–35 °C normal range, and 10,000 ft RAM AIR limit. The cards drill packs, bleed, distribution, and abnormal handling.



02

BLEED AIR SYSTEM - STUDY CARDS

BLEED AIR SOURCES

What sources supply the bleed air manifold?

- Engine IP bleed air (normal in-flight)
- APU bleed air (right side of manifold only)
- External ground cart (right side of manifold only)

HP vs IP VALVES

How do HP and IP valves differ in function?

- HP valves regulate HP bleed to 36 ± 3 psi for wing anti-ice
- IP valves supply ECS; IPV limits pressure to 50 ± 3 psi
- IASC 1 monitors left; IASC 2 monitors right

CROSSBLEED VALVE

What does the XBLEED valve enable?

- Divides manifold into left and right sides
- Opens for cross-engine bleed starting
- Requires ≥ 32 psi bleed pressure for crossbleed start

APU BLEED VALVE

Who controls the APU bleed valve and how?

- Controlled by APU Electronic Control Unit (ECU)
- ECU senses APU exhaust temperature to modulate flow
- Fails closed when APU shuts down or signal is lost

ENGINE START SEQUENCE

What valves move during an engine start?

- Cross bleed valve opens; flow control valves close
- Associated start valve opens; ATS engages
- After self-sustaining: ATS out, start valve closes, FCVs return

BLEED FAIL TRIGGER

When is L (R) BLEED FAIL (C) posted?

- IPV fails AND manifold pressure exceeds 60 psi; also triggered by temperature limit exceedance or sensor failure. Caution-level EICAS.
- Caution-level EICAS message
- Low thrust at high field elevation may cause bleed valve to close

03

BLEED AIR MANIFOLD & VALVES - STUDY CARDS

MANIFOLD LOCATION

Where is the bleed air manifold?

- Located in engine pylons and aft equipment bay
- Left and right sides divided by XBLEED valve
- Engines supply respective sides

CHECK VALVES

How many check valves, and what do they do?

- Four check valves in bleed air ducting
- IP check valves prevent reverse flow into engines
- APU and ground air check valves prevent backflow

APU/ENGINE SWITCHING — TAKEOFF

Normal T/O and landing configuration?

- APU bleed ON, engine bleeds OFF
- XBLEED switch OPEN
- Single source feeds each duct at all times

APU/ENGINE SWITCHING — CLIMB

Bleed configuration during climb?

- XBLEED CLOSED, L BLEED ON, R BLEED ON
- APU bleed switched OFF
- APU OFF after transition

APU/ENGINE SWITCHING — APPROACH

Bleed transition during approach?

- Start APU, then R BLEED OFF, APU BLEED ON
- L BLEED OFF, XBLEED OPEN
- Only one source feeding any duct at a time

BLEED LEAK DETECTION - STUDY CARDS

SYSTEM OVERVIEW

Who controls leak detection and how?

- Fully automatic — controlled by IASCs
- Monitors bleed air and anti-ice ducts
- 8 zones reported to EICAS

EIGHT ZONES

Name the eight leak detection zones.

- 1 Left bleed duct 2 Right bleed duct
- 3 L wing anti-ice 4 R wing anti-ice
- 5 R pylon 6 L pylon 7 Pack ducts 8 Trim air ducts

SINGLE vs DUAL LOOPS

Which zones use single vs dual loops?

- Single loops: left/right bleed ducts and trim air ducts
- Dual loops: pylon ducts, aft equipment bay, anti-ice leading edges
- Dual loops minimize false indications; allow dispatch with one loop inoperative

LOOP FAIL vs FAULT

What is the difference between FAIL and FAULT?

- LOOP FAIL — both sensing loops inoperative
- LOOP FAULT — one of two sensing loops inoperative
- Dual-loop design allows dispatch under MEL with one loop out

DUCT CONSTRUCTION

What materials are bleed air ducts made of?

- Stainless steel, titanium, or aluminum
- Wrapped with insulation
- Vent holes in covers direct leaking air to sensing loops



ECS / PACK · STUDY CARDS

IASC CHANNELS

What does each IASC channel do?

- Channel A: air conditioning, avionics cooling, cabin pressurization
- Channel B: wing anti-ice, bleed leak detection, backup A/C
- IASC 1 Ch B also has backup cabin pressure sensor

PACK AIR FLOW

Describe bleed air flow through the PACK.

- Precooler → primary HX (temp reduced) → ACM compressor
- Secondary HX (more cooling) → reheater/condenser (water extracted)
- ACM turbine (temp drops, near cabin pressure) → condenser HX

TEMPERATURE CONTROL

How is PACK outlet temperature controlled?

- Temperature control valve modulates hot bypass air
- Normal mode: 15 °C – 35 °C
- Manual (MAN) mode: 10 °C – 70 °C

FLOW CONTROL VALVES

What are the FCVs and who commands them?

- Electrically controlled, pneumatically operated modulating shutoff valves
- Commanded by AIR SOURCE selector on AIR COND/BLEED panel
- Control mass airflow through PACK and TRIM AIR

RAM AIR COOLING

How does ram air cool the heat exchangers?

- In flight: dynamic pressure opens plenum check valve; fan bypassed
- On ground: ACM fan generates suction to pull airflow
- Exhausted overboard after passing through HX chain

GROUND BLEED SOURCE

Why is APU preferred on the ground?

- Engines at ground idle may produce insufficient pressure
- APU recommended for reliable PACK operation
- Ground cart also acceptable

PACK AIR CYCLE — KEY PATH

- Bleed air → Precooler → Primary HX (ram air cools it)
- ACM Compressor raises pressure/temperature → Secondary HX cools again
- Reheater/Condenser extracts water → Water Extractor
- ACM Turbine expands air to near-cabin pressure (big temp drop)
- Condenser HX final pass → cabin supply
- Temperature control valve blends hot bypass to set outlet temp

AIR SOURCE SELECTOR · STUDY CARDS

AIR SOURCE — OFF

What happens when AIR SOURCE is selected OFF?

- Both flow control valves closed
- No bleed air enters for pressurization or air conditioning
- **AIR SOURCE OFF** (S) CAS message displayed

AIR SOURCE — NORM

What is the NORM position?

- Normal position — left and right bleed both allowed
- Bleed flows through PACK and TRIM AIR valves
- Conditioned air supplied to cabin

AIR SOURCE — PACK ONLY

When and how is PACK ONLY used?

- Left FCV opens, right FCV closes, PCV closes
- All bleed flows through PACK only — trim air valves inactive
- Used when TRIM AIR failure exists; **PACK ONLY** (S) CAS posted

AIR SOURCE — TRIM AIR ONLY

When and how is TRIM AIR ONLY used?

- Right FCV opens, left FCV closes, PCV closes
- All bleed through trim air valves only — PACK bypassed
- Used when PACK failure; **TRIM AIR ONLY** (S) CAS posted

AIR SOURCE SELECTOR — QUICK REFERENCE

- OFF → both FCVs closed; no cabin air; AIR SOURCE OFF status
- NORM → both FCVs open; PACK + TRIM AIR both active
- PACK ONLY → left FCV open, right FCV + PCV closed; PACK ONLY status
- TRIM AIR ONLY → right FCV open, left FCV + PCV closed; TRIM AIR ONLY status



TRIM AIR SYSTEM - STUDY CARDS

TRIM AIR PURPOSE

What does the trim air system provide?

- Hot trim air for normal cabin temperature control
- Normal cabin pressurization
- Backup pressurization/conditioning if PACK is completely lost

HARSOV

What are the HARSOVs and where are they?

- Hot Air Regulating Shutoff Valves — two total
- One for cabin LP distribution, one for cockpit LP distribution
- Located in unpressurized aft equipment bay

HACKV

What do the Hot Air Check Valves protect?

- Two HACKVs isolate pressurized area from unpressurized aft bay
- Prevent cabin decompression if trim air supply duct fails
- Located just downstream from trim air bulkhead

TRIM AIR INJECTORS

How many injectors and where?

- Three trim air injectors total
- Two for cabin supply, one for cockpit supply
- Fed from precooler outlet (trim air side)

TRIM AIR SYSTEM COMPONENTS

TRIM AIR SYSTEM COMPONENTS

- Trim air ducting, 2 HARSOVs, 2 HACKVs
- 3 trim air injectors (2 cabin + 1 cockpit)
- Most components located in aft equipment bay

RAM AIR & AIR DISTRIBUTION - STUDY CARDS

RAM AIR INLET

Where is the ram air inlet and what cools what?

- Located at base of vertical fin
- Flows through secondary HX → primary HX → precooler HX
- Exhausted overboard through exhaust vents

RAM AIR VALVE

When and how is the RAM AIR valve used?

- Used if air conditioning system (PACK + TRIM AIR) fails
- Provides cockpit and cabin ventilation below 10,000 ft
- Select guarded RAM AIR switch to ON after descending below 10,000 ft

COCKPIT DISTRIBUTION

How is conditioned air distributed to the cockpit?

- Duct runs under floor from aft bulkhead to cockpit
- Outlets: foot/leg level, side console grilles, overhead gaspers
- Gaspsers supply cold air only; all others are temperature controlled

CABIN DISTRIBUTION

How is cabin air distributed?

- Two main ducts deliver temperature-controlled bleed air at BOTH foot AND head level (head-level via upper feed line integral to interior furniture). Gaspsers are a separate coldair system.
- Head level via overhead gaspers (cold air only)
- Upper feed line runs between skin and liner at head level

LAVATORY VENTILATION

How is lavatory odor contained?

- More air exhausted underfloor than supplied to lavatory
- Negative pressure flow prevents odors entering cabin
- Vent in lavatory wall equalizes pressure

EXHAUST PATH

Where does exhaust air go?

- Cabin: under floor → outflow valve; some heats battery compartment
- Cockpit: under floor → outflow valve; via center pedestal holes
- All ultimately dumped overboard through pressure control system



AVIONICS COOLING · STUDY CARDS

AVIONICS COOLING COMPONENTS

What cools the avionics?

- Underfloor fan and avionics cooling valve
- Both draw air from cockpit panel area or above avionics racks
- Normal control by IASC 1; degraded control by IASC 2

FAN OPERATING MODES

When does the fan run at high vs. low speed?

- Ground: high-speed mode
- Flight: low speed normally
- Flight: switches to high speed if rack reaches 122 °F (50 °C) in 60 sec

OVERHEAT RESPONSE

What happens if rack temperature reaches 149 °F?

- Above 10,000 ft: fan turns off; IASC opens avionics cooling valve
- Triggers if temperature exceeds 149 °F (65 °C) in 60- second period
- **EQPT RACK TEMP HIGH (C)** CAS posted

DEGRADED MODE

How does degraded avionics cooling work?

- IASC 2 takes over control
- Avionics fan commanded on
- If fan fails, avionics cooling valve opens

EQPT RACK CAS MESSAGES

What CAS messages indicate avionics cooling issues?

- **EQPT RACK COOL FAULT (A)** — fan or valve failure
- **EQPT RACK TEMP HIGH (C)** — overheat condition in avionics rack
- EQPT RACK TEMP HIGH requires immediate crew action

AVIONICS COOLING — TEMPERATURE THRESHOLDS

- Ground: fan runs at HIGH speed continuously
- Flight / normal: fan runs at LOW speed
- 122 °F (50 °C) in 60 sec → fan switches to HIGH speed
- 149 °F (65 °C) in 60 sec, above 10,000 ft → fan OFF; cooling valve OPEN
- **EQPT RACK COOL FAULT (A)** — fan or valve failed
- **EQPT RACK TEMP HIGH (C)** — overheat detected

EICAS · CAUTION

CAUTION MESSAGES

Timely crew awareness/action needed

Message	Meaning	Inhibits
L (R) BLEED FAIL	Bleed air valve failed OR temperature/pressure exceeded limits OR sensor failed. (Low thrust may yield insufficient pressure to keep valve open; 60 psi manifold-pressure threshold applies when valve fails and pressure rises above that value.)	TO/LAND
EQPT RACK TEMP HIGH	Avionics rack temperature overheat condition detected	TO/LAND

ADVISORY MESSAGES

Crew awareness - no immediate action required

Message	Meaning	Inhibits
EQPT RACK COOL FAULT	Avionics cooling fan or valve has failed	TO/LAND

EICAS · STATUS

STATUS MESSAGES

Information only - no crew action required

Message	Meaning
AIR SOURCE OFF	Air source selector positioned to OFF — no bleed to cabin
PACK ONLY	Air source selector in PACK ONLY — trim air valves closed
TRIM AIR ONLY	Air source selector in TRIM AIR ONLY — PACK flow valves closed



12

QUICK RECALL · NUMBERS GRID

Cover the labels and recite the number; reverse and recite the label.
Repeat until automatic.

2 IASCs (air system controllers)	50 ± 3 psi IPV bleed pressure limit	36 ± 3 psi HP valve regulated pressure	60 psi L/R BLEED FAIL trigger
32 psi Min for crossbleed start	8 zones Leak detection zones	4 Check valves in bleed ducting	15–35 °C Normal temp range
10–70 °C MAN mode temp range	10,000 ft RAM AIR valve max altitude	20,000 ft APU bleed max altitude	2 HARSOVs Trim air regulating valves
2 HACKVs Trim air check valves	3 Trim air injectors	122 °F / 50 °C Fan high-speed threshold	149 °F / 65 °C Cooling valve opens threshold

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